COMPETITIVE POSITION MULTIVARIATE ANALYSIS OF 1000 TOP EU COMPANIES IN 2013 – RESEARCH AND DEVELOPMENT PERSPECTIVE

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Abstract: *In the Knowledge-Based Economy R&D activity of companies seemed to be crucial. The paper presents the possibility of using zero unitharisation method to identify those EU companies which are characterized by the highest levels of multidimensional R&D position. As a result there was created synthetic Q ratio fro each of 1000 objects (Enterprises). Sorted from highest to lowest value of Q ratio became a ranking of competitive position of companies in EU from R&D activity point of view. The purpose of the article is to present possibility of usage of multivariate analysis to evaluate the competitive position of enterprise. Author presents zero unitharisation method with Q ratio as a tool that solves the problem of low level of utility of one-dimensional analysis. In the research multivariate competitive position evaluation of top 1000 EU companies in 2013 leads to the conclusion that competitive position based on Research and Development activity depends on many factors (not only on R&D expenses). In one dimensional rating proposed by EU in "Scoreboard R&D ranking of world top 1000 companies" first place was for Volkswagen. This position resulted from the highest R&D expenditure in the amount of 11,7 bilion of EUR. In Multidimensional rating Volkswagen is on the sixth place. The difference is due fact that in multidimensional analysis besides R&D expenditures there were taken into account 8 more indicators value of which is linked to R&D expanses.*

Keywords: *company, EU, research, Q ratio*

JEL Classification: *M15, M21*

1. INTRODUCTION

In the Knowledge-Based Economy high performance of research and development (R&D) can be demonstrate not only by non-monopoly or oligopoly operating conditions. Companies with small number of employees, with a relatively low level of physical capital, high level of intellectual capital can also achieve high levels of free cash flow. This put s a new light on the thesis of Schumpeter that the performance of R&D is an increasing function of the size of the company [1]. Differences in R&D performance is one of three broad determinants of differences in the market performance, the other two being differences in investment and differences in the ownership of complementary assets [2],[3].

Firm's research and development expenditure is usually connected with its competitive position and value creation process. Some research finds a positive short-term stock market reaction to announcements of increased R&D expenditure [4],[5]. Other research show that companies with significant R&D expenditure increases experience positive long-term unusual stock returns and improved its operating performance [6], [7]. Moreover increase of R&D expenditure is typical for companies that are related with better absorbent possibilities are creating more benefits from R&D spillover effects [8]. However, you should take into account, that R&D incoming spillovers might not have an direct impact on firm valuation when there is an unexpected increase in R&D, because stakeholders may have objections measuring the degree of the company incoming vs R&D spillover effect [9],[10],[11]. Companies have different incoming spillovers, depending on technology flows, foreign direct investment, an R&D investment itself [12], [8], [13], [11], [14]. Nowadays companies are spending relatively significant amounts on R&D (see Figure 1.). Top 20 EU companies spent over 75 billion of EUR on R&D in 2013.

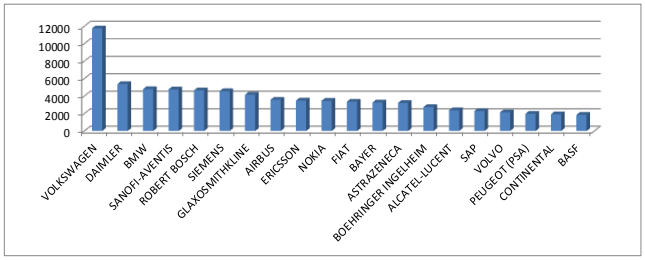

Figure 1 R&D expenses of Top 20 EU companies in 2013 (million EUR)
Source: Own calculation

There has been a debate in the literature about the positive relation between the level of R&D expenditures and future stock returns and competitive position of the company [15], [16], [17], [18], [19], [20]. Beginning of the research on competitive advantage of enterprises due at the beginning of the nineties the twentieth century [21], [22], [18], [23], [24]. In the process of creating a competitive advantage crucial for companies is spending on R&D. This applies particularly to High-Tech and Medium, High-Tech companies. The activities of R&D are aimed at working out a chance to create innovations ready for commercialization [25]. Several studies [26], [27], [20], [28], [29] showed that investment in R&D translate into a positive rate of return, profitability or rate of implementation of innovations.

R&D activity is closely related to innovation and creative destruction concept of J.A. Schumpeter. A main interest in the creative destruction concept [30],[1] is to account for

the differences in R&D performance on the market between when a radical change in technological regimes occurs, what can generate a "discontinuity" [31]. In fact, systematic underperformance in R&D against competitors is widely considered one of the main explanations for their market failure [32]. Development of civilization and Knowledge-Based Economies leads to increase of complexity of competitiveness evaluation process. There is no doubt that in practice almost every evaluation must be multidimensional. Reflections presented in this paper are placed in the theory of value based management in the field of values drivers, Critical success factors and key performance indicators. The purpose of the paper is to present possibility of usage of multivariate (multidimensional) analysis to evaluate the competitive position of enterprise. Author presents zero unitarisation method with synthetic Q ratio as a tool to create competitive position ranking from R&D activity perspective.

2. METHODOLOGY

The research was based on European Union (UE) top 1000 companies ranked by R&D expenses [33]. The "EU Industrial R&D Investment Scoreboard" includes companies' 18 economic indicators such as: R&D 2013 (mln EUR), R&D 1 year growth (%), R&D 3 years growth (CAGR-3y, %), R&D intensity (%), Sales 2013 (mln EUR), Sales 1 year growth (%), Sales 3 years growth(CAGR-3y, %), Capex 2013 (mln EUR), Capex 1 year growth (%), Capex 3 years growth (CAGR-3y, %), Capex intensity (%), Profits 2013(mln EUR), Profits 1 year growth (%),Profits 3 years growth (CAGR-3y, %), Profitability (%), Employees 2013, Employees 1-year growth (%) and Employees 3-years growth (CAGR-3y, %). Data correspond to the companies' latest published accounts. For most companies these correspond to calendar year 2013, but a significant proportion have financial years ending on 31 March 2014. The R&D investment included in the Scoreboard is the cash investment that is funded by the companies themselves. It excludes R&D funded by contracts with third parties such as governments or other firms [34].

From 18 indicators (diagnostic variables) for 1000 companies (objects), because of the gaps in the values of indicators, there were selected 9 indicators for research: R&D 2013 (mln EUR), R&D 1 year growth (%), R&D 3 years growth (CAGR-3y, %), Sales 2013 (mln EUR), Sales 1 year growth (%), Profits 2013 (mln EUR), Profits 1 year growth (%), Profitability (%) and Employees 2013. As a result, in the study there were 1000 objects and 9 indicators which resulted in a 9000 observations. One of the important objectives is that commercialization of innovation resulting from R&D activity should be reflected in the sales, profits or profitability.

Historically, the bulk of applications of multivariate techniques have been in the behavioral and biological sciences. However, interest in multivariate methods has now spread to numerous other fields of investigation [35]. Behavioral, social, and educational phenomena are often multifaceted, multifactorially determined, and exceedingly complex. Any systematic attempt to understand them, therefore, will typically require the examination of multiple dimensions that are usually intertwined in complicated ways [36]. The normalization process of diagnostic variables is crucial in multicriterial estimation of objects and their ranking structure. There are a lot of normalization methods. In this paper there is used zero unitarisation method which provides a simple and easy tool in the construction of objects rankings due to the level of a variety of complex phenomena. The paper presents the possibility of using zero unitarisation as a taxonomy method for the construction of a multidimensional ranking. The procedure consisted of the following stages of the calculation:

1. Creating a matrix of Enterprises and Indicators

	I_1	I_2	I_3	…	I_m
E_1	X_{11}	X_{12}	X_{13}	…	X_{1m}
E_2	X_{21}	X_{22}	X_{23}	…	X_{2m}
E_3	X_{31}	X_{32}	X_{33}	…	X_{3m}
…	…	…	…	…	…
E_n	X_{n1}	X_{n2}	X_{n3}	…	X_{nm}

(1)

Where:

$E_{1…n}$ – Enterprise

$I_{1…m}$ – Indicator

X_{nm} – the value of m-th features (I - Indicator) of the n-th object (E – Enterprise)

2. Due to the fact that the features can be stimulants, destimulants or nominants before next step there should be (if necessary) used procedure to bring uniformity of characteristics (features). In the study assumed that number of employees is destimulant. The lower the number of employees at a given level of profit, sales and spending on R&D, the better.

The second step of the calculation is to bring the different variables comparable titers with standardization. As a result of diagnostic normalization of each variable is made according to the following formula:

$$z_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \qquad \max_i x_{ij} \rangle \min_i x_{ij} \quad (2)$$

Where:

z_{ij} - normalized value of j-th features of the i-th object,

x_{ij} - the value of j-th features of the i-th object,

min x_{ij} - minimum value of j-th features of the i-th object,

max x_{ij} - maximum value of j-th features of the i-th object.

As a result there will be matrix:

	sI_1	sI_2	sI_3	…	sI_m
E_1	Z_{11}	Z_{12}	Z_{13}	…	Z_{1m}
E_2	Z_{21}	Z_{22}	Z_{23}	…	Z_{2m}
E_3	Z_{31}	Z_{32}	Z_{33}	…	Z_{3m}
…	…	…	…	…	…
E_n	Z_{n1}	Z_{n2}	Z_{n3}	…	Z_{nm}

(3)

3. Determination of the synthetic ratio Q allows to determine the ranking of enterprises. To estimate the value of the indicator was used the following formula:

$$Q_i = \sum_{j=1}^{s} z_{ij} \quad (4)$$

4. The last research stage was to estimated value to the classification ranges according to the following formulas:

Class A for: $(av.Q+2\sigma_Q ; max\ Q>$, (5)

Class B for: $<av.Q - 2\sigma_Q ; av.Q+2\sigma_Q>$, (6)

Class C for: $<min\ Q ; av.-2\sigma_Q)$. (7)

Where:

max Q – maximum value of synthetic ratio Q,

min Q – minimum value of synthetic ratio Q,

σ_Q – standard deviation of synthetic ratio Q,

av.Q – average value of synthetic ratio Q.

The advantage of the synthetic ratio which is that the result is a one (synthetic) variable indicating the direction and magnitude of changes in the assessment process allowing objectify the phenomenon of competitive position resulting from R&D activity. As a result there were created rating of 1000 companies where ranks were divided into three classes A, B and C. Class A is for best companies according to multidimensional analysis, class B is for average companies and class C is for worst companies.

3. FINDINGS

The advantage of multidimensional analysis of competitive position is that in evaluation there taken into account more than one feature defining characteristic phenomenon. The results from the synthetic Q ratio point of view differ from the one-dimensional ranking (based only on the R&D expenditure).

An average value of synthetic Q ratio of the research sample (av. Q) was 3,806056, while the standard deviation was 0,196822. Therefore according to the formulas 5, 6 and 7 there were designated 3 intervals classes as below:

- Class A is for the interval of Q ratio (4,1997; 5,34895 >,
- Class B is for the interval of Q ratio <3,41241; 4,1997>,
- Class C is for the interval of Q ratio <2,6364; 3,41241).

Class A is the best companies in proposed multi-dimensional ranking. Class B are average companies and Class C are worst companies in a multi-dimensional ranking. As a result of the study we classified 28 companies for Class A (see Table 1.), 963 companies for Class B (typical area of variability) and 10 companies for Class C (see Table 2.). In Class A it has been classified as 1 company form Austria, Ireland and Finland, 2 firms form Italy, 3 firms from Sweden (first and third place in ranking) and France, 4 firms from Germany and 13 companies form UK. In Class A Industrial sectors occurred as follows: Pharmaceuticals & Biotechnology (5 times), Software & Computer Services (5 times)(most common sectors in Class A), Oil & Gas Producers and Automobiles & Parts (3 times), General Industrials (4 times), Gas, Water & Multi-utilities and Electricity (2 times), Support Services, Financial Services, Construction & Materials and Banks (1 time). First place in ranking belonged to Carl Bennet (Q=5.348959), the second place to Royal Dutch Shell (Q=5.299098) and the third place to Ecolean (Q=5.278747).

In one dimensional rating proposed by EU in "Scoreboard R&D ranking of world top 1000 companies" on the first place was classified Volkswagen company. This position resulted from the highest R&D expenditure in the amount of 11,7 billion of EUR. You can not, however, agree with the statement that the company that has spent the most on R&D is a company with the top ranked from R&D activity perspective. In Multidimensional rating Volkswagen is on the sixth place. The difference is due fact that in multidimensional analysis besides R&D expenditures there were taken into account 8 more indicators value of which is linked to R&D expenses. If we treat R&D as a value driver of a company this specific expenditure should have should have reflected either in ssales, profits or profitability. The worst of all 1000 companies was G4S form UK (Q=2,636484). What is interesting in Class C of proposed ranking were 4 widely recognized brands (Italian Unicredit 991st place, Belgian Dexia 992nd place, British Tesco 994th place and German Deutsche Post 996th place).

Table 1. Class A (the best) of 1000 top EU R&D companies from Q ratio point of view in 2013

No	Company	Country	Industrial sector (ICB-3D)	Q ratio
1	CARL BENNET	Sweden	Support Services	**5,348959**
2	ROYAL DUTCH SHELL	UK	Oil & Gas Producers	**5,299098**
3	ECOLEAN	Sweden	General Industrials	**5,278747**
4	HUHTAMAKI	Finland	General Industrials	**5,136753**
5	ESS	Sweden	Pharmaceuticals & Biotechnology	**4,985905**
6	VOLKSWAGEN	Germany	Automobiles & Parts	**4,828892**
7	BP	UK	Oil & Gas Producers	**4,821805**
8	KING DIGITAL ENTERTAINMENT	Ireland	Software & Computer Services	**4,771363**
9	VALNEVA	France	Pharmaceuticals & Biotechnology	**4,722037**
10	STYROLUTION HOLDING	Germany	General Industrials	**4,700437**
11	TOTAL	France	Oil & Gas Producers	**4,677629**
12	COMPACTGTL	UK	Gas, Water & Multi-utilities	**4,665594**
13	CANTAB BIOPHARMACEUTICALS	UK	Pharmaceuticals & Biotechnology	**4,521743**
14	VELTI	UK	Software & Computer Services	**4,509003**
15	BMW	Germany	Automobiles & Parts	**4,502301**
16	SNAM	Italy	Gas, Water & Multi-utilities	**4,485464**
17	CSG EQUITYCO	UK	Software & Computer Services	**4,420564**
18	LONDON STOCK EXCHANGE	UK	Financial Services	**4,418103**
19	MONITISE	UK	Software & Computer Services	**4,40241**
20	DAIMLER	Germany	Automobiles & Parts	**4,398131**
21	GENTIUM	Italy	Pharmaceuticals & Biotechnology	**4,348323**
22	MELROSE INDUSTRIES	UK	General Industrials	**4,319281**
23	UBISOFT ENTERTAINMENT	France	Software & Computer Services	**4,316874**
24	NORTHERN POWERGRID	UK	Electricity	**4,312647**
25	SCOTTISH AND SOUTHERN ENERGY	UK	Electricity	**4,269156**
26	WAAGNER BIRO	Austria	Construction & Materials	**4,244338**
27	GLAXOSMITHKLINE	UK	Pharmaceuticals & Biotechnology	**4,213803**
28	BARCLAYS	UK	Banks	**4,202656**

Source: Own calculation

The values of synthetic Q ratio of top 1000 EU Companies in 2013 were presented in chart (see Figure 2) where in OY axis were marked values of Q ratio and on OX axis were marked ordinal numbers of the objects (companies).

Table 2. Class C (the worst) of 1000 top EU R&D companies from Q ratio point of view in 2013

No	Company	Country	Industrial sector (ICB-3D)	Q ratio
1	UNICREDIT	Italy	Banks	**3,372659**
2	DEXIA	Belgium	Banks	**3,370173**
3	METRO	Germany	General Retailers	**3,368468**
4	TESCO	UK	General Retailers	**3,278685**
5	STANDARD LIFE	UK	Life Insurance	**3,252699**
6	DEUTSCHE POST	Germany	Industrial Transportation	**3,116202**
7	METALYSIS	UK	Industrial Metals & Mining	**2,925687**
8	FRONTIER SILICON HOLDINGS	UK	Electronic & Electrical Equipment	**2,920488**
9	OASMIA PHARMACEUTICAL	Sweden	Pharmaceuticals & Biotechnology	**2,753124**
10	G4S	UK	Support Services	**2,636484**

Source: Own calculation

Additionally Class A, B and C of companies position in the rating were marked on the Figure 2 below with vertical lines on 28th and 990th company, which forms the boundary of class. Q synthetic ratio values ranked from highest to lowest are arranged in the characteristic shape of "lying S-curve". It is interesting that similar to "lying S-curve" shape occurs with other methods of multivariate comparative analysis (inter alia using a positive development pattern, using negative development pattern, with other algorithms of unitarisation or normalization of data).

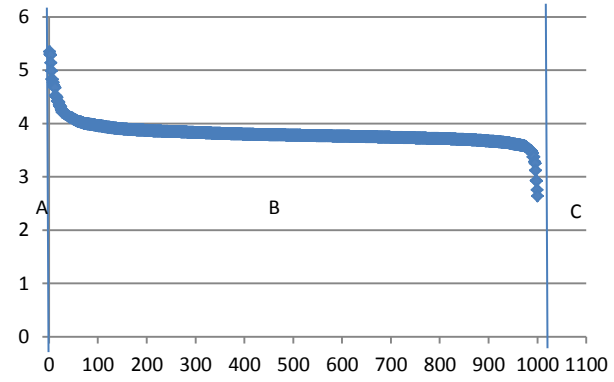

Figure 2 Synthetic Q ratio of top 1000 R&D EU companies in 2013

Source: Own calculation

Significant impact on the final results of the ranking was the maximum values of the various indicators of the analyzed companies. The more the maximum values of 9 indicators the higher position in multidimensional ranking. Moreover, this is the main reason why the one-dimensional rank differs from multidimensional ranking. The author is aware that the proposed tool for analysis has its drawbacks. However, under the maxim that "better to be right more or less, than precisely be wrong", using the simplest methods from group of methods of multidimensional comparative analysis is a more appropriate approach than using a single indicator for the construction of ranking and conclusions based on such a complex phenomenon as the research and development activity.

5. CONCLUSION

As one result of the economic success of European Union in the past two decades should be increased innovation resulting from investment in R&D. These assumptions appeared in both the "Lisbon Strategy" and subsequent documents of the European Commission. In 2013, the top world R&D investors continued to increase their Research and Development investments by 4.9%, more than the growth of net sales (2.8%). This suggests the importance of R&D investments in a context of increased competition and economic uncertainty. However the poor R&D growth performance of EU companies in relevant high-tech sectors such as Pharmaceuticals & Biotechnology (0.9%) and Technology Hardware & Equipment (-5.4%) weigh down the total average R&D increase of the EU sample. The overall amount invested in R&D by EU based companies in high-tech sectors represents 43.3% of the amount invested by their US counterparts and the gap between the two company samples is increasing with time [33]. Economic conditions heavily influence EU R&D activity. EU problems with Greece, Spain and Italy influence 2014 R&D investments. Balancing this state is to be seen on the side of Germany, France and the U.K. The EU had negative growth in 2013, and it is projected to grow at only about 1% per year through 2017. R&D activity is expected to follow a similar path.

In the research multidimensional competitive position evaluation of top 1000 EU companies in 2013 leads to the conclusion that competitive position based on Research and Development activity depends on many factors (not only on R&D expenses). Reflections presented in this paper were placed in the theory of value based management and took into account research and development activity of the companies as a value driver. R&D activity should be treated as value driver and R&D investment may be key performance indicator. Research and Development activity of a company should express in generating sales, profits and above all cash flow. When attempting to assess the R&D activities of the companies trying to omission this important iterations appears to be incorrect. You can not agree with the statement that the company that has spent the most on R&D is a company with the top ranked from R&D activity perspective. Development of civilization and Knowledge-Based Economies leads to increase of complexity of competitiveness evaluation process. There is no doubt that almost every competitive position evaluation should be multivariate (multidimensional).

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